CHAPTER

13

BOOTING WINDOWS XP

After reading this chapter and completing the exercises, you will be able to:

- Understand the Windows XP boot process
- Troubleshoot system restoration by using Safe Mode
- Explain the operation of the key Windows XP startup files
- Understand the boot options offered through the Windows Advanced Options Menu
- Edit the Boot.ini file to manipulate the boot process
- Understand how multiboot configurations are created and how they function

On the surface, booting a computer might seem simple. But in reality, booting is a complex process. In fact, it is important to understand each step of the process by which an inert hunk of metal becomes a computer running Windows XP. This understanding is essential for the Microsoft certification exam, and for troubleshooting a system that won't boot properly.

In this chapter, you learn the steps that Windows XP takes to successfully complete a boot process. The process begins with the initial operation of the hardware, as it finds pointers to the software that ultimately leads to the choice of which operating system to run (and as it goes through the process of loading and starting Windows XP). The process culminates when the logon dialog box appears. It is only at this point that the Windows XP boot process is considered to be complete. At logon, the system makes a backup of the Registry and stores it as the Last Known Good Configuration. However, prior to logging on, the kernel, all subsystems, and services are started. This means scheduled tasks will execute at their appointed time and other network users can access shared resources from this system. But to complete the boot process, you must perform a successful logon.

The Boot Process

All computers, whether hosting Windows XP or another operating system, go through a similar **boot process** when they are turned on. In Windows XP, this process is broken down into two major phases: the **boot phase** and the **load phase**.

The Windows XP boot process is actually a two-part process that includes both the boot phase and the load phase. The boot process takes place when the computer is first powered on, and when you choose Restart from the Shut Down Windows dialog box. This dialog box appears when you select Shut Down from the Start menu.

Windows XP Boot Phase

The six steps of the Windows XP boot phase are as follows:

1. Power-on self test (POST)
2. Initial startup
3. Boot loader
4. Selecting the operating system
5. Detecting hardware
6. Selecting a configuration

Power-On Self Test

The **power-on self test (POST)** is the first step in the boot sequence for any computer with an operating system. The POST determines the amount of real memory, and whether or not all necessary hardware components, such as a keyboard, are present. The actual tests can differ, depending on how the **BIOS (Basic Input/Output System)** is configured. If the tests are successful, the computer boots itself. If the tests are unsuccessful, the computer reports the error by emitting a series of beeps and possibly displaying an error message and code on the screen. The number of beeps indicates the error, but differs from one BIOS to another. The software for the POST resides in a special, battery-powered chip called the **CMOS (complementary metal-oxide semiconductor)**. This chip can store not only the software necessary to conduct the POST, but also basic configuration information that the POST uses to check the amount of RAM installed in a system, along with other key information. Figure 13-1 shows a typical screen that results from the successful completion of the POST on an Intel PC.

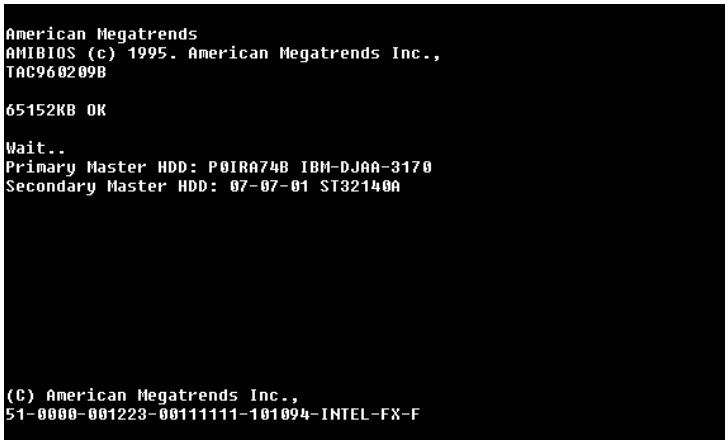

Figure 13-1 The POST display on a PC

After the system POST is completed, each adapter card in the system performs its own self-test. For example, if a computer has a SCSI card installed in addition to its own built-in adapter cards, it checks its internal configuration and any related devices it sees when it runs its own POST. At the same time, a report on what it finds during this process appears on the computer monitor in text-only form (because there is no real operating system running at this point, screen output at this stage of the boot process is kept as simple and direct as possible). The screen shown in Figure 13-2 adds the report from an Adaptec 2940 SCSI controller to the information already supplied by the POST routine.

Figure 13-2 Output from the BIOS on an Adaptec 2940 SCSI controller

Initial Startup

The initial startup sequence involves numerous files and initialization procedures. The first sector of the hard disk contains the Master Boot Record (MBR) and the partition table. The **Master Boot Record (MBR)** begins the boot process by looking up the partition table to determine which partition to use for booting. If you are booting from a floppy disk, the first sector contains the **partition boot sector**.

Table 13-1 outlines the startup files for Windows XP on x86 computers.

Table 13-1 Windows XP Startup Files

Filename	Location	Explanation
Ntldr	Root of startup disk	Windows XP boot loader for PC machines
Boot.ini	Root of startup disk	Windows XP PC boot menu information
Bootsect.dos	Root of startup disk	Provides DOS boot information for dual-boot PCs
Ntdetect.com	Root of startup disk	Windows XP hardware detection program
Ntbootdd.sys	Root of startup disk	Lets Windows XP access SCSI drives on PCs with SCSI controller with onboard BIOS disabled
Ntoskrnl.exe	*%systemroot%*\system32	Windows XP operating system kernel
Hal.dll	*%systemroot%*\system32	Hardware abstraction layer code (CPU driver for x86 chips)
SYSTEM key	*%systemroot%*\system32	Key Windows XP Registry data
Device drivers	*%systemroot%*\system32	PC-specific device drivers for Windows XP use

When the POST has successfully concluded, the BIOS tries to locate the startup disk. The BIOS represents a chip-based set of routines that DOS and Windows 95/98 use to drive all system input and output, including access to peripheral devices. Windows XP, on the other hand, uses its own built-in input/output logic and drivers, and ignores whatever BIOS is installed in a computer. By doing this, Windows XP is able to manage I/O more carefully than earlier Windows and DOS operating systems. It also helps to explain why applications that attempt to access drivers or the computer's BIOS or hardware directly are treated as ill behaved in the Windows XP environment.

If a floppy disk is in drive A when the BIOS checks that drive, it might use that drive as the startup disk (this decision depends on how the boot sequence has been configured in the PC's CMOS). If there is no floppy disk in that drive, or if the CMOS has been configured to boot from a hard disk, it uses the first hard disk it finds as the boot disk. Of course, if drive A is enabled for booting, and the floppy disk you have inserted in that drive does not have a partition boot sector, you get a "Non-system disk or disk error: Replace and press any key when ready" message, and the system won't start. This is one of the most common causes of boot failure in the Windows XP environment.

If you get the "Non-system disk or disk error" message because the system attempted to boot from a non-system floppy, remove the floppy and cycle the power off and on again. It is important to do this (rather than restarting with Ctrl+Alt+Delete) to avoid transferring boot-sector viruses to the computer.

When the BIOS uses the hard disk as its startup disk, it reads the MBR and loads that into memory. The BIOS then transfers system control to the MBR. The MBR scans the partition table to locate the system partition. When the MBR locates the system partition, it loads sector 0 of the partition into memory, and executes it. Sector 0 (zero) can contain a diagnostic program, a utility such as a virus scanner, or a partition boot sector that contains the startup code for the operating system. Should the computer boot from a floppy, only the partition boot sector is used.

In general, the MBR is independent of the operating system. For example, the same MBR is used in x86 systems to boot to Windows 95, 98, MS-DOS, Windows 2000, Windows NT, Windows XP, and Windows 3.x.

The partition boot sector is completely dependent on the operating system and file system in use. For example, the partition boot sector in a Windows XP computer is responsible for a number of operating-system-specific functions. It must understand enough of the file system in use to find **Ntldr** (the program that locates and loads the Windows XP operating system files in the root folder). On a hard drive with a FAT partition, the partition boot sector is generally one sector long, and points to another location on disk that ultimately permits the computer to find and launch Ntldr. On an NTFS partition, because the partition boot sector can be as many as 16 sectors long, it can contain all the necessary file system code needed to locate and launch Ntldr, without requiring transfer of control to another area on disk. Thus, the partition boot sector is responsible for loading a boot loader (Ntldr) into memory and initiating boot loader execution.

At this point, the **system partition**, the partition that contains the MBR and partition boot sector, must be on the first physical hard drive in the system. However, the **boot partition**—the partition that contains the Windows XP files—can be on the same partition, a different partition on the same drive, or on another drive entirely within the local computer. In other words, you boot Windows XP from the system partition, and run the operating system from the boot partition.

Because this terminology is counterintuitive and because it appears on numerous Windows XP-related Microsoft exams, it's important to remember this reversal of terminology.

Boot Loader

Boot loader processing and files select an operating system to boot, and load the related operating system files from the boot partition. On PCs, once the boot OS is selected

from the Boot.ini menu, Ntldr controls the operating system selection and hardware detection processes before the Windows XP kernel is initialized.

Ntldr, Boot.ini, Bootsect.dos, Ntdetect.com, and Ntbootdd.sys may all be present in the root directory of the startup disk (also known as the system partition; see Figure 13-3). Some files might be dimmed because they have the read-only attribute. The partition hosting the boot loader can be formatted with FAT, FAT32, or NTFS. Of this collection of files, Ntldr, Ntdetect.com, and Boot.ini must always be present for Windows XP to boot (the other two are optional, and depend on the configuration of the particular machine in use).

The Folder Options applet must be configured to show all hidden and system files; otherwise, most of these boot files will not be shown.

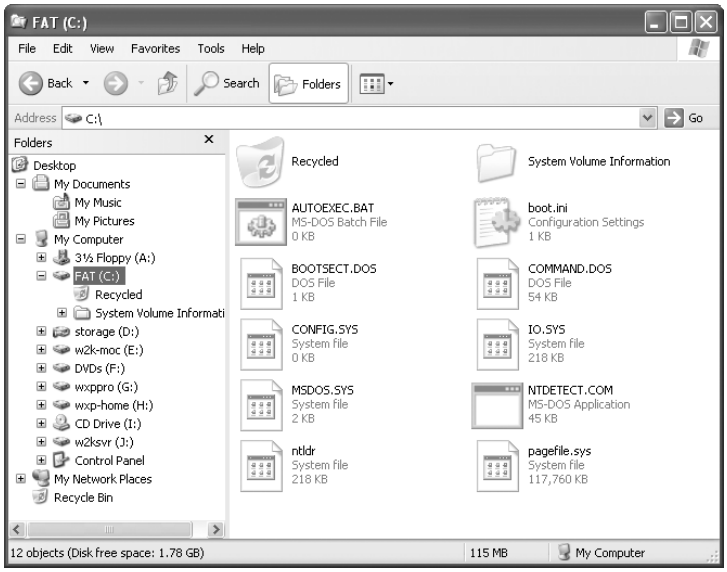

Figure 13-3 The system partition on a typical Windows XP system

Bootsect.dos appears only if the machine has been configured to dual-boot between Windows XP/2000/NT and DOS, Windows 3.x, or Windows 9x. Ntbootdd.sys appears only when a SCSI controller has its built-in BIOS controller disabled; this file supplies the necessary controller driver that the hardware would otherwise provide.

At this point, Ntldr switches the processor into 32-bit flat memory mode. When an x86 computer starts, it is running in real mode, which means it is functioning as an old-fashioned 8088 or 8086 computer. Because Ntldr is a 32-bit program, it must

change the processing mode to support the 32-bit flat memory model it uses before it can perform any further processing.

Next, Ntldr starts the appropriate file system. The code to access both FAT and NTFS file systems is programmed into Ntldr so that it can read, access, and copy files on either type of file system.

Next, Ntldr reads the Boot.ini file and displays the operating system selections it contains. The screen that appears at this point is usually called the boot loader screen or the **boot selection menu**, and represents the point at which users can select which operating system they would like to load (or which form of Windows XP graphics operation they would like to use).

A typical boot selection menu appears in Figure 13-4. Notice the prompt to access troubleshooting and advanced startup options by pressing F8. These options are discussed in a later section of this chapter.

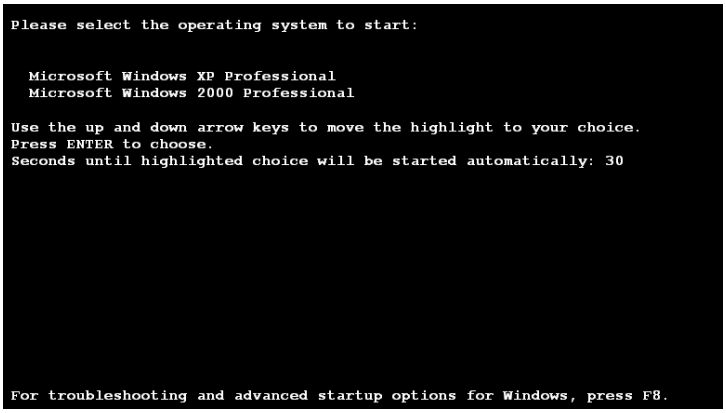

Figure 13-4 A typical Windows XP boot selection menu

Notice on this particular system, Windows XP Professional is present with Windows 2000 Professional. In fact, Windows XP coexists with numerous other operating systems, including those that depend on DOS for their underpinnings.

When you do not manually alter the highlighted selection of the boot menu, a line below the menu displays a counter: "Seconds until highlighted choice will be started automatically: 30." If a selection is not made before the counter reaches zero, the highlighted operating system starts automatically. To change the default operating system to load or the amount of time to wait before automatically loading the highlighted operating system, change the settings in the Boot.ini file, which is discussed in greater detail later in this chapter. In addition, pressing the up arrow or down arrow key halts the timer.

If the user selects an operating system other than Windows XP or Windows NT, the boot loader loads Bootsect.dos and hands over control of the system. The other operating system then starts normally because Bootsect.dos contains the partition boot sector

for that operating system. However, if the user selects a version of Windows XP, the boot loader executes Ntdetect.com to gather hardware information.

The remaining functions of Ntldr (operating system selection, hardware detection, and configuration selection) are discussed later in this section. For now, note that Ntldr maintains control of the computer until it loads Ntoskrnl.exe and passes the hardware information and system control to that program.

Detecting Hardware

Ntdetect.com is executed by the boot loader and is used to collect a list of hardware currently installed in the computer. Ntdetect checks the computer ID, bus/adapter type, video, keyboard, communication ports, parallel ports, floppy disks, and mouse or pointing devices. It creates a system profile to be compared to Windows XP Registry entries that describe the system later during the boot process, at which point the operating system looks for discrepancies or potential problems.

Once hardware is detected, the system needs to select a system configuration, otherwise known as a hardware profile. If a single hardware profile is defined, this is the one that is used. If two or more hardware profiles are present, the system attempts to select a profile based on detected hardware. If the system cannot make an automatic selection, you'll be prompted to manually select a hardware profile.

Troubleshooting and Advanced Startup Options

Windows XP has combined the boot and recovery options of Windows NT and Windows 95/98. The result is a more robust operating system and additional options to restore a malfunctioning system to a functional state. To access the additional startup options, when the boot menu appears, press F8 before the timer expires. Once F8 is pressed, the Windows Advanced Options Menu appears (see Figure 13-5).

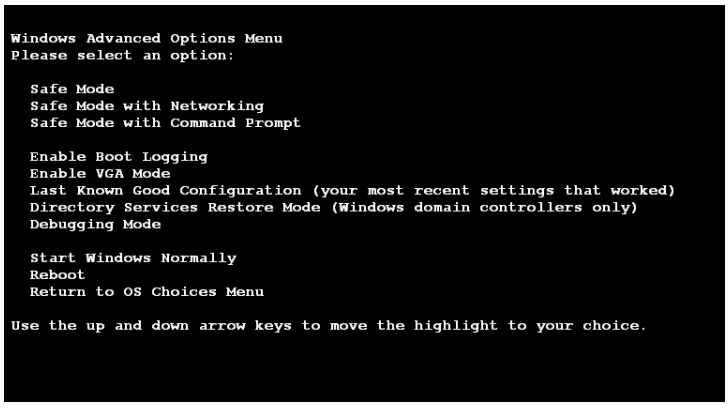

Figure 13-5 The Windows Advanced Options Menu

The contents of this menu are somewhat dependent on installed components, such as the Remote Installation Service, but it typically contains the following items:

- *Safe Mode*—Boots Windows XP with only the minimum required system files and device drivers. Safe Mode does not load networking components (see Hands-on Project 13-3)
- *Safe Mode with Networking*—Boots Windows XP in the same manner as Safe Mode, but adds networking components (see Hands-on Project 13-6)
- *Safe Mode with Command Prompt*—Boots Windows XP in the same manner as Safe Mode, but boots to a command prompt instead of to the GUI environment
- *Enable Boot Logging*—A toggle that enables or disables the boot process and writes details to a log file regarding drivers and services. The log file is located at %systemroot%\Ntbtlog.txt
- *Enable VGA Mode*—Boots Windows XP normally, but uses only the basic VGA video driver (see Hands-on Project 13-5)
- *Last Known Good Configuration*—Boots Windows XP with the **Last Known Good Configuration (LKGC)**, the state of the Registry as it was recorded during the last successful user logon (see Hands-on Project 13-4)
- *Directory Services Restore Mode*—Valid only on Windows XP domain controllers; used to boot Windows XP and restore Active Directory
- *Debugging Mode*—Boots Windows XP normally, but sends debugging information to another system over a serial cable. Details about using this option are included in the *Microsoft Windows XP Professional Resource Kit*.

Advanced Options for booting can be used to recover from a wide variety of system problems or failures. Safe Mode offers the ability to boot into a functioning system even when specific drivers are corrupted or failing. This includes bypassing bad video drivers, network drivers, and GUI controls by booting into Enable VGA Mode, Safe Mode (without networking support), and/or Safe Mode with Command Prompt, respectively. In most cases, this allows you to replace or remove the problematic driver before rebooting back into normal mode.

If a problem is occurring and you are unable to discern its exact cause or nature, you might want to choose Enable Boot Logging from the Advanced Options menu to record the process of steps performed between the boot menu and the logon prompt. The resultant file, *%systemroot%*\Ntbtlog.txt, can provide clues as to the driver, system, or procedure that is causing the system malfunction.

If you've recently installed a driver or entire software product, or just modified the Registry, and the result is a system that does not fully boot, the Last Known Good Configuration is a great first step in returning the system to a functional state. The LKGC returns the system to the state of the Registry at the time of the last successful logon.

If none of these options provides you with a method to restore your system, you do have one final option from the Windows Advanced Options Menu, namely Debugging Mode. This mode is used in conjunction with a second computer connected by a serial cable. Debugging Mode causes the boot process to send detailed information on activities to the companion system. This information can be used to determine at what point in the boot process problems are occurring. The information created by Debugging Mode is rather complex and is typically used only by high-end programmers. If you want more details on the Debugging Mode process and how to interpret the extracted data, consult the *Microsoft Windows XP Professional Resource Kit*.

Boot Configuration and Selecting an Operating System

The Windows XP boot configuration can be controlled through its configuration file, Boot.ini. As previously mentioned, Boot.ini is located in the root directory of the system partition, and is used by the boot loader to display the list of available operating systems. This file consists of two sections: [boot loader] and [operating systems]. A typical Boot.ini file is shown in Figure 13-6.

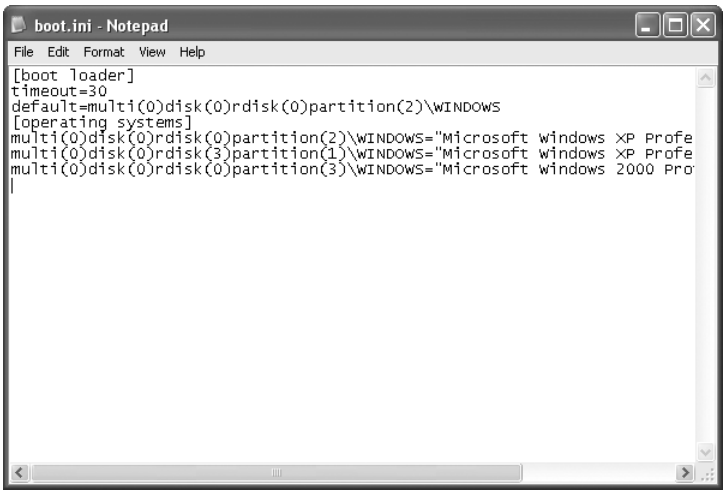

Figure 13-6 Boot.ini viewed through Notepad

[boot loader]

The [boot loader] section of the Boot.ini file contains two items: timeout and default. The *timeout* setting defines the number of seconds the system waits for the user to select an operating system before loading the default operating system. If timeout is set to zero, Ntldr immediately loads the default operating system without displaying the boot loader screen. To cause the system to wait indefinitely for a selection, set the timeout to -1. This setting,

however, can only be altered by using a text editor, because it is an illegal value for the setting from the System icon in the Control Panel. (See the section later in this chapter on editing Boot.ini, which explains how to edit this file, and what kind of text editor to use.) The *default* setting in Boot.ini lists the path to the default operating system.

[operating systems]

The [operating systems] section of Boot.ini lists the available operating systems. Each listing contains the path to the boot partition for the operating system, the text displayed in the boot loader screen, and optional parameters. The text is clipped in the screen capture in Figure 13-6, but here's what it looks like in its entirety:

```
multi(0)disk(0)rdisk(0)partition(2)\WINDOWS="Microsoft
Windows XP Professional" /fastdetect

multi(0)disk(0)rdisk(3)partition(1)\WINDOWS="Microsoft
Windows XP Professional" /fastdetect

multi(0)disk(0)rdisk(0)partition(3)\WINDOWS="Windows 2000
Professional"
```

The following list details some of the switches that can be added to the end of entries in the [operating systems] section of Boot.ini. In most cases, you'll want to employ the F8 Windows Advanced Options Menu (see earlier this chapter) to access troubleshooting boot methods. However, you can employ the following switches and switch combinations to mimic the Windows Advanced Options Menu selections in your Boot.ini file:

- */BASEVIDEO*—Starts Windows XP in standard VGA mode (640 x 480) with 16 colors
- */BAUDRATE=n*—Sets the baud rate for the serial connection used in kernel debugging. The default is 9600, a setting up to 115,200 can be used.
- */BOOTLOG*—Enables boot logging
- */CRASHDEBUG*—Loads the kernel debugger but remains inactive until a STOP error occurs
- */DEBUG*—Loads the debugger and allows access by a host debugger connected to the computer
- */DEBUGPORT={com1|com2|1394}*—Sets the port for debugging
- */FASTDETECT={com1|com2|…}*—Specifies a serial port to skip during bootup hardware scanning. If no com port is specified, all ports are skipped.
- */MAXMEM=n*—Sets the maximum amount of RAM the OS can consume
- */NOGUIBOOT*—Boots without showing the splash screen. Does not determine whether Windows XP GUI environment or command prompt is booted.

- */NODEBUG*—Disables the debugger
- */NUMPROC=n*—Sets the number of processors on a multi-CPU system the OS is allowed to use
- */SAFEBOOT:MINIMAL*—Boots into Safe Mode
- */SAFEBOOT:NETWORK*—Boots into Safe Mode with Networking
- */SAFEBOOT:MINIMAL(ALTERNATESHELL)*—Boots into Safe Mode with Command Prompt
- */SOS*—Displays the device driver names when they are loaded

The switches used in the Boot.ini file are not case sensitive.

Advanced RISC Computing Pathnames

In the Boot.ini file, the path pointing to the \WINDOWS directory is written using the **Advanced RISC Computing (ARC) pathname** naming conventions. These pathnames are described as follows:

- *scsi(n) or multi(n)*—This portion of the path indicates the type of the device on which the operating system resides. *scsi* is used if the operating system is on a SCSI hard disk that is connected to a SCSI adapter that has a disabled built-in BIOS. *multi* is used for other hard disks including IDE, EIDE, and SCSI with a built-in BIOS. The *(n)* indicates the hardware adapter from which to boot. It is replaced with a number corresponding to the correct hardware adapter, numbered ordinally (starting with zero).
- *disk(n)*—This portion of the path indicates which SCSI bus number should be used. The *(n)* always equals zero when the adapter is a multiadapter (that is, the ARC494 path starts with multi); otherwise, it is numbered ordinally.
- *rdisk(n)*—This portion of the path indicates the SCSI LUN number or selects which of the hard disks attached to the adapter contains the operating system. *(n)* always equals zero when the adapter is SCSI; otherwise, it is numbered ordinally.
- *partition(n)*—This portion of the path selects the disk partition that contains the operating system files. Partition is numbered cardinally (starting with 1).
- *\path*—The final portion of the path indicates the directory on the partition in which the operating system files are found. The default path for Windows XP is \WINDOWS.

EDITING BOOT.INI

To make changes to a Boot.ini file, the user has two options: to use the Control Panel to edit this file indirectly, or to use a text editor to change the file directly.

Using the Control Panel

Using the Control Panel to make changes to Boot.ini is the safest way to proceed (try Hands-on Project 13-1). By opening the System applet in the Control Panel (Classic View), selecting the Advanced tab, then clicking the Settings button in the Startup and Recovery pane (see Figure 13-7), you can make certain changes to your setup. The Startup and Recovery dialog box (shown in Figure 13-8) allows you to choose a default boot selection and to select a delay interval before the boot selection starts automatically. This delay time corresponds to the timeout value set in Boot.ini. These options are depicted in the System startup pane in the Startup and Recovery dialog box. Notice also that the options that control debugging output for system failures appear on this pane as well; this information often comes in handy when severe problems become manifest.

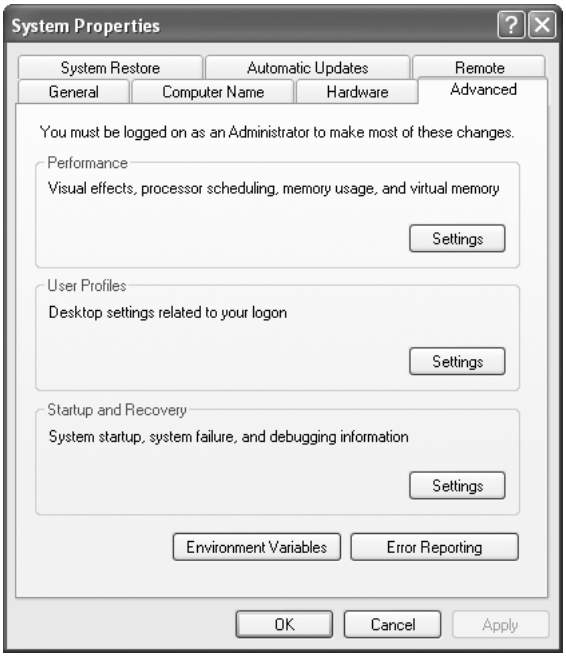

Figure 13-7 The Advanced tab of the System applet

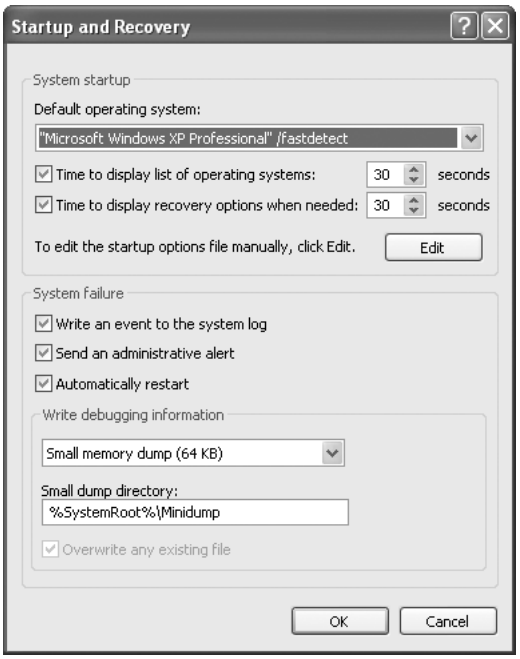

Figure 13-8 The Startup and Recovery dialog box

Using a Text Editor

You can use Notepad or any other text editor to edit Boot.ini (try Hands-on Project 13-2). As with any initialization file, you should be careful when editing the file. If you configure the file incorrectly, Windows XP might not boot. You should always create a backup copy of the file and name it Boot.bak before you make any changes.

Windows XP Load Phase

The Windows XP load phase begins when the kernel assumes control of the machine. It consists of the following five stages:

- Loading the kernel
- Initializing the kernel
- Services load
- Windows XP system start
- Logging on

Loading the Kernel

Once you've selected the option to boot into Windows XP, a brief "Starting Windows…" text message is displayed before the full Windows XP splash screen is shown. While you are "entertained" by the image, the boot loader loads the Windows XP kernel (Ntoskrnl.exe) and the hardware abstraction layer (HAL; file Hal.dll) into memory. However, these programs are not executed at this time. Before executing the programs, the boot loader loads the Registry key HKEY_LOCAL_ MACHINE\SYSTEM from the *%systemroot%*\system32\Config\System directory.

At this point, the boot loader retrieves the configuration you selected from the Registry subkey HKEY_LOCAL_MACHINE\SYSTEM\Select. Based on the ControlSet00x setting in the subkey, the boot loader knows which ControlSet00x to use. For example, if you chose the Last Known Good Configuration option during the configuration selection process, the **control set** may be ControlSet003 rather than ControlSet001, which is the default configuration. Notice the values of the Current, Default, Failed, and LastKnownGood value entries in Figure 13-9. (Working with the Registry and the contents of Registry keys are covered in Chapter 12.)

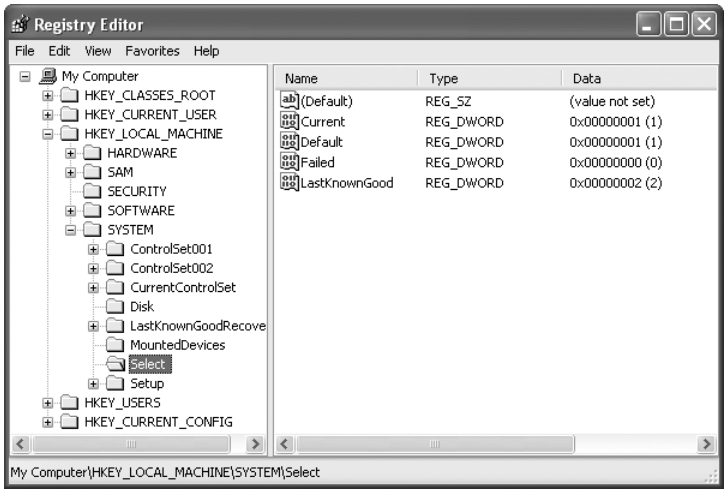

Figure 13-9 The HKEY_LOCAL_MACHINE\SYSTEM\Select subkey viewed through Regedit

The boot loader then loads the drivers listed in the Registry subkey HKEY_LOCAL_ MACHINE\SYSTEM\CurrentControlSet\Services. These drivers are loaded and/or initialized according to their settings in the Registry.

Initializing the Kernel

After its initialization, the kernel creates the Registry key HKEY_LOCAL_MACHINE\ HARDWARE, using the information received from the boot loader. This key contains

the hardware information that is computed when the system is started up, and includes information about components on the system board and the interrupts used by specific hardware devices.

The kernel also creates the CloneControlSet by making a copy of the CurrentControlSet. The Clone set is never modified, because it is intended to be an identical copy of the data used to configure the computer and should not be modified during the startup process.

The kernel then initializes the drivers that were loaded by the boot loader. If drivers experience errors as they load, they send conditions to the kernel that determines how the error is treated. The error levels are as follows:

- *Ignore*—The error is ignored and no message is displayed to the user, if the ignore condition is sent to the kernel.
- *Normal*—The boot process continues, but a message is displayed to the user if the device driver returns the normal error condition.
- *Severe*—The management of this error depends on whether the Last Known Good Configuration is in use or not. If the LKGC is not being used, then the error is displayed to the user, and the boot process restarts using the LKGC. If the LKGC is already in use, then the message is displayed and the boot process continues.
- *Critical*—The management of this error depends on whether the LKGC is in use or not. If not, then the error is displayed to the user, and the boot process restarts using the Last Known Good Configuration. If the LKGC is already in use, then the message is displayed and the boot process fails.

All such events are saved automatically in the System log, and invoke on-screen messages as well. The System log is available as one of the views in the Windows XP Event Viewer (Start | Control Panel | Administrative Tools | Event Viewer), and should always be checked whenever errors are reported during the boot process. Because that process cannot be interrupted, however, it's necessary to wait and inspect the log after the bootup phase is complete.

Services Load

During the services load phase, the kernel starts the Session Manager, which reads the entries that are stored in the Registry key: HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Session Manager.

It then starts programs that correspond to the key entries under this Registry key: HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Session Manager\BootExecute.

The default entry for this key is *autocheck autochk* *. Autocheck makes sure that the files stored on your hard drive are always consistent. It detects and attempts to repair damaged

files and directories. As with any repair utility, it cannot guarantee that all files can be fixed or retrieved.

Once Autocheck is complete, the paging files are set up. These are stored under HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Session Manager\Memory Management.

The Session Manager then writes the CurrentControlSet and the CloneControlSet to the Registry, and, finally, loads the subsystems that are defined in the Registry.

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\SessionManager \Subsystems contains the subsystem information. The Windows (Win32) subsystem is the default subsystem for Windows XP, and is also the subsystem within which the default user shell always executes.

Windows XP System Startup

Once the Windows XP services have all started, and the elements in the group of processes that are configured to launch on startup are fired off, the Windows XP system can be considered to be fully started. This brief but meaningful phase of the process is signaled by the appearance of the Windows XP logon screen as the Win32 subsystem starts winlogon.exe, and that process automatically launches the Local Security Administration (lsass.exe) process.

Logging On

Until a user successfully logs on, the boot process is not complete. Once a user logs on, the Clone control set is copied to the Last Known Good control set. This procedure provides the values to be used the next time the machine is powered up, if the user elects to invoke the Last Known Good Configuration.

Multiple-Boot Systems

One of the biggest advantages of the Windows XP operating system is its ability to peacefully coexist with other operating systems. Each operating system uses one or more file systems to organize the data within the volumes. Some operating systems can use the same file system, whereas others are incompatible. For example, MS-DOS, Windows 95/98, Window NT, Windows 2000, and Windows XP are able to share files through FAT volumes, and Windows NT, Windows 2000, and Windows XP are able to share files through NTFS volumes. Windows XP and UNIX do not have a common file system, although it is possible for Linux to access FAT volumes.

In addition to the file system issue, you must also keep in mind that only Windows 2000 and Windows XP support dynamic disks. All other operating systems cannot see the volumes on dynamic disks nor any of the resources stored on them. Even from within Windows 2000 or XP, you must import the foreign dynamic disk before you can access its contents.

When selecting a file system to format a partition, keep in mind the capabilities of each OS. MS-DOS, Windows 3.1, and Windows 95 support only FAT. Windows 95 OSR2 and Windows 98 support only FAT and FAT32. Windows NT (SP4+), Windows 2000, and Windows XP support FAT, FAT32, and NTFS. To install MS-DOS, Windows 3.1, Windows 95, OSR2, or Windows 98 in a multi-boot configuration with Windows NT, 2000, or XP, the boot partition must be formatted with FAT.

Multiple Windows Operating Systems

Windows 3.1, Windows 3.11, Windows 95/98, Windows NT, and Windows 2000 can all exist on the same system as Windows XP. When Windows XP is to be installed on a system with another operating system—especially some previous version of Windows—it is important to specify a different installation partition. Unless you want to upgrade the computer (that is, install Windows XP over an existing OS), always define a new main directory and partition different from the one already in use. Different versions of Windows XP can also be installed on the same computer, but, again, each must have a separate partition.

If you plan to use applications from the different versions of Windows you have installed, you must install the application from each operating system. For example, if you intend to use Microsoft Word from both Windows 98 and Windows XP, you must run the Word set-up program while the computer is booted to each operating system.

Multiple Installation Order

When installing multiple operating systems on x86-based computers, the order in which you install the operating systems is important. When installing Windows XP and MS-DOS, it is best to install MS-DOS first, then Windows XP. Windows XP sees the DOS operating system and leaves it intact. The same guideline applies to installing Windows XP and Windows 95/98 or Windows 2000. At this time, the recommended installation order is: older Windows products first, then Windows XP. If you plan on running all three operating systems (MS-DOS, Windows 98, and Windows XP), they should be installed in that order: MS-DOS, then Windows 98, and Windows XP last. When installing multiple versions of Windows XP or Windows 2000 onto the same system, it really doesn't matter which one is installed first. As a general rule, install the newest operating system last and the oldest first.

Chapter Summary

- The Windows XP boot process can be daunting, but it is not nearly as mysterious as one first supposes. It follows the same general boot steps as any other operating system, and, in fact, "plays well with others." After the POST (power-on self test), the BIOS loads the Master Boot Record (MBR), which then loads the partition boot sector. Then the boot loader takes control of the system and begins the true Windows XP boot. The user is presented with options for choosing the operating system to load, and—if he or she chooses Windows XP—the configuration to use.

- When the boot menu appears, you can press F8 to access the Windows Advanced Options Menu. The advanced options are alternate boot methods that can bypass certain types of drivers or subsystems to aid in troubleshooting. Advanced options include, among others, Safe Mode, Enable VGA, Enable Boot Logging, and Last Known Good Configuration.
- After the boot loader, the kernel is loaded into memory and is granted control of the computer. The kernel loads the operating system files and device drivers before finally allowing the user to logon. When the user successfully logs on to the computer, it is considered a good startup and the configuration is saved to the Registry.
- The boot process can be altered by changing the Boot.ini file. This includes information such as the default operating system, its location, and the amount of time to wait before automatically loading the default OS. The type of information displayed and the debugger setting can be changed by adding switches to the configurations in the Boot.ini file.
- Windows 3.1, Windows 3.11, Windows 95/98, Windows NT, and Windows 2000 can all exist on the same system as Windows XP. You can configure Windows XP to offer the choice of booting to other operating systems. In a multiboot system, it's generally best to install in chronological order, from older operating systems to newer ones.

KEY TERMS

Advanced RISC Computing (ARC) pathname — Naming convention used in the Boot.ini file to define the particular hard disk and partition where Windows XP operating system files reside.

BIOS (Basic Input/Output System) — A special PC ROM chip that contains sufficient program code to let a computer perform a POST routine, to check its hardware components, and to operate basic input and output routines for keyboard or mouse input, and screen output.

boot partition — In Windows XP, the disk that contains the Windows XP operating system files.

boot phase — Any of a number of stages in the Windows XP boot process, starting with the POST, through initial startup activities, to activation of a boot loader program, to selection of the operating system (or version) to boot, to hardware detection (Ntdetect), to selecting a configuration.

boot process — The process of bringing up a completely functional computer, starting from initial power-up (or reboot) through the boot phases and load phases involved in starting the hardware, finding a boot loader, and then loading and initializing an operating system.

boot selection menu — The list of bootable operating systems (or versions) that Boot.ini provides for display at the end of the Windows XP boot phase.

complementary metal-oxide semiconductor (CMOS) — A special, battery-powered chip that can store not only the software necessary to conduct the POST, but also the basic, nonvolatile configuration information that POST uses to check the RAM installed in a system, the number and type of hard drives, the type of keyboard and mouse, and so forth.

control set — A special set of Registry values that describes a Windows XP machine's startup configuration that is saved each time a Windows machine is shut down (as the current configuration) and each time a user successfully logs on for the first time after bootup (as the Last Known Good Configuration).

Last Known Good Configuration (LKGC) — The control set for Windows XP that is automatically saved by the system in a special set of Registry keys the first time a user logs on successfully to a system immediately after it has booted up. This information provides a safe fallback to use when booting the system the next time, if changes made to the Registry in the interim cause problems with booting (or if changes have been introduced that a user does not want to retain on that system).

load phase — The Windows XP load phase begins when the kernel assumes control of the machine, and consists of the following five steps: (1) loading the kernel, (2) initializing the kernel, (3) loading services, (4) starting the Windows XP system, and (5) logging on. All five steps must be completed successfully for a complete load to occur.

Master Boot Record (MBR) — The partition table for a disk, and the code that permits that partition table to be read. A functioning MBR is required to boot a hard disk.

Ntldr — The Windows XP loader program that manages the boot and load phases of Windows XP on a PC.

partition boot sector — The partition that contains the information the file system uses to access the volume, including a physical description of the disk, the name and version of the operating system files, the bootstrap code, and an instruction that allows the Master Boot Record to find all this information.

power-on self test (POST) — The system check performed by all computers when they are turned on.

system partition — In Windows XP, the disk that contains the MBR and partition boot sector.

Review Questions

1. Which of the following partitions contain the files that load the initial components of the operating system?
   a. boot partition
   b. system partition
   c. start partition
   d. kernel partition

2. What program has control of an x86 computer when the user is able to choose which operating system to boot?
   a. Ntldr
   b. Osloader
   c. Boot.ini
   d. Ntbootdd.sys
3. When configuring an x86 computer for multiple operating systems, _____ should always be loaded last.
4. When booting an x86 computer, the boot loader must be installed on a(n) _____ file system. (Choose all that apply.)
   a. NTFS
   b. HPFS
   c. FAT
   d. FAT32
5. Which Boot.ini file setting defines the operating system that will be automatically loaded?
   a. [operating systems]
   b. [system loader]
   c. [boot loader]
   d. default=
6. When a Windows XP Professional system is not installed as a domain client, the _____ logon method is used by default.
7. What is the primary boot loader for x86-based systems?
   a. Ntldr
   b. Osloader.exe
   c. Bootdd.sys
   d. Bootsect.dos
8. The timeout option is in the _____ section of the Boot.ini file.
9. What portion of a computer system startup is the same on all computers?
   a. POST
   b. initial startup
   c. boot loader
   d. OS selection

10. The Boot.ini file can be changed by one of two methods. What are they?
    a. Control Panel System applet
    b. Control Panel Startup applet
    c. Windows XP Configuration Manager
    d. using a text editor
11. Which of the following files is accessed only when SCSI disks with onboard BIOS disabled are used?
    a. Multidisk.sys
    b. Scsildr.sys
    c. Rdisk.sys
    d. Ntbootdd.sys
12. Which of the following are selections listed on the Windows Advanced Options Menu when you press F8 during the boot menu display? (Choose all that apply.)
    a. Safe Mode with Command Prompt
    b. Enable VGA Mode
    c. NTFS Transfer Mode
    d. Debugging Mode
13. Which ARC settings are used only for SCSI controllers without an enabled onboard BIOS? (Choose all that apply.)
    a. multi()
    b. scsi()
    c. rdisk()
    d. disk()
14. The Ntoskrnl.exe file is located in the _____ directory on an x86 system.
15. The Last Known Good Configuration is accessed by pressing the spacebar after the operating system is selected from the boot menu. True or False?
16. You recently installed a new video driver and a new networking interface driver, and now your system will not boot, or at least you never see the logon prompt. Which of the following advanced options should you use to attempt to return to a fully functional system?
    a. Safe Mode
    b. Safe Mode with Networking
    c. Safe Mode with Command Prompt
    d. Enable VGA Mode
    e. Enable Debugging Mode
    f. Enable Boot Logging

17. What are the Boot.ini parameter switches that mimic the Safe Mode with Networking Windows Advanced Options Menu selection?
    a. /SAFEBOOT:MINIMAL(ALTERNATESHELL) /SOS /BOOTLOG /NOGUIBOOT
    b. /SAFEBOOT:DSREPAIR /SOS
    c. /SAFEBOOT:NETWORK /SOS /BOOTLOG /NOGUIBOOT
    d. /BOOTLOG
18. Which of the following boot.ini switches displays the names of the device drivers as they are loaded?
    a. /B
    b. /AT
    c. /SOS
    d. /DRV
19. The Last Known Good Registry key is written or updated after _____.
20. The _____ partition contains the Windows XP operating system files.
    a. system
    b. boot
    c. start
    d. kernel
21. If the system and boot partitions are the same and reside on an IDE hard drive, which of the following ARC names would appear in Boot.ini?
    a. scsi(0)disk(0)rdisk(1)partition(1)
    b. multi(0)disk(0)rdisk(0)partition(1)
    c. multi(0)disk(1)rdisk(0)partition(1)
    d. multi(0)disk(0)rdisk(1)partition(1)
22. Windows XP uses its own built-in input/output logic and drivers, and ignores whatever BIOS is installed in a computer. True or False?
23. The presence of a floppy in drive A can cause which of the following situations? (Choose all that apply.)
    a. booting from the floppy to whatever OS is installed there
    b. failure to boot due to a missing boot sector on the floppy
    c. "Non-system disk or disk error: Replace and press any key when ready" error message
    d. normal booting from the hard drive
24. The same MBR is found on Windows 95, MS-DOS, Windows NT, Windows 2000, Windows XP, and Windows 3.x systems. True or False?

25. Ntbootdd.sys appears on a system when which of the following operating systems is present in a multiboot configuration with Windows XP?
    a. MS-DOS
    b. Windows 3.x
    c. Windows 98
    d. none of the above

HANDS-ON PROJECTS

Project 13-1

To modify the Boot.ini file by using Control Panel:

1. Open the Control Panel (**Start**|**Control Panel**).
2. Double-click the **System** applet (assuming the Control Panel is in Category View).
3. Select the **Advanced** tab (refer to Figure 13-7).
4. Click the **Settings** button in the Startup and Recovery section. This reveals the Startup and Recovery dialog box (refer to Figure 13-8).
5. Notice that the system startup option defines the default operating system for the computer. Select another operating system from the drop-down list.
6. To modify the amount of time the list appears when the system is booted, change the **Time to display list of operating systems:** option. Change this setting to **10** seconds by clicking on the down arrow beside the field.
7. The remaining options define that action for the kernel to take when a STOP error occurs. In most situations, these should not be changed.
8. To save the configuration to Boot.ini, click **OK**.
9. To see the effect of the changes you made, restart the computer.
10. Repeat this process to restore the original settings.

Project 13-2

To change the Boot.ini settings using a text editor:

1. First create a backup copy of the Boot.ini file: Launch Windows Explorer (**Start**|**All Programs**|**Accessories**|**Windows Explorer**); select the root of drive C in the left pane. Right-click the **Boot.ini** entry, select the **Copy** entry, then click on the current drive and press **Ctrl+V** (paste). This creates a file named "Copy of boot.ini" in that directory. Rename the file to **Boot.bak**. Click **Yes** on the confirmation windows that appear. This information can come in handy in case something goes wrong later.

2. Open the Boot.ini file in Notepad by selecting **Start|Run**, then type **notepad c:\boot.ini** in the box provided, and click **OK**. Notepad opens with the Boot.ini file displayed (refer to Figure 13-6).
3. Restore the timeout to 30 seconds by changing the **timeout=** value to **30**.
4. Save the file by selecting **File|Save**.
5. Exit Notepad by selecting **File|Exit**.
6. Reboot the computer to deploy your changes.

Project 13-3

Rebooting Windows XP into Safe Mode:

1. Restart Windows XP by selecting **Start|Shut down**. Select **Restart**. Click **OK** (assuming Classic logon mode).
2. As Windows XP reboots, watch for the boot selection menu. As soon as it appears, press **F8**. This reveals the Windows Advanced Options Menu. (Refer to Figure 13-5.)
3. Use the arrow keys on the keyboard to select **Safe Mode** from the list of options.
4. Press **Enter**, and allow the boot process to continue to completion.
5. Your system boots with minimal drivers and without network support.
6. Repeat step 1, and allow your machine to reboot normally.

Project 13-4

Rebooting Windows XP with the Last Known Good Configuration:

Performing this project causes all changes made to the system since the last successful logon to be discarded.

1. Restart Windows XP by selecting **Start|Shut down**. Select **Restart**. Click **OK** (assuming Classic logon mode).
2. As Windows XP reboots, watch for the boot selection menu. As soon as it appears, press **F8**. This reveals the Windows Advanced Options Menu (refer to Figure 13-5).
3. Use the arrow keys on the keyboard to select **Last Known Good Configuration** from the list of options.
4. Press the **Enter** key, and allow the boot process to continue to completion.
5. Your system boots with the state of the Registry recorded at the last successful logon.

Project 13-5

Rebooting Windows XP with minimal VGA support:

This boot method should be used when a bad video driver is present or incorrect resolution has been set.

1. Restart Windows XP by selecting **Start|Shut down**. Select **Restart**. Click **OK** (assuming Classic logon mode).
2. As Windows XP reboots, watch for the boot selection menu. As soon as it appears, press **F8**. This reveals the Windows Advanced Options Menu (refer to Figure 13-5).
3. Use the arrow keys on the keyboard to select **Enable VGA Mode** from the list of options.
4. Press **Enter**, and allow the boot process to continue to completion.
5. Your system boots normally, but uses the standard VGA video drivers at 640 x 480 with a color depth of 16 or 256 (depending on your video card). This allows you to correct your display resolution or replace the bad video driver.

Project 13-6

Rebooting Windows XP into Safe Mode with Networking:

1. Restart Windows XP by clicking **Start|Shut down**. Select **Restart**. Click **OK** (assuming Classic logon mode).
2. As Windows XP reboots, watch for the boot selection menu. As soon as it appears, press **F8**. This reveals the Windows Advanced Options Menu (refer to Figure 13-5).
3. Use the arrow keys on the keyboard to select **Safe Mode with Networking** from the list of options.
4. Press **Enter**, and allow the boot process to continue to completion.
5. Your system boots with minimal drivers but includes network support. This boot method is useful when attempting to troubleshoot a system that requires network access to tools, data files, or traffic.

CASE PROJECTS

1. The Engineering Department in your company has decided to update their computers to Windows XP Professional. They currently have four PCs, two running Windows 3.11 and two running Windows 95. They would like to retain their current configurations and programs. Outline the steps necessary to install Windows XP on their systems and explain what configurations will be available after the update is complete.
2. After installing a new graphics controller on a Windows XP Professional machine, you start up the system, but when the boot process is complete, you see nothing on the monitor except a small dot of light in the exact center. What boot option can you use to see enough of the screen to try a different driver, or to change display settings in the Display Control Panel applet?
3. By default, the Boot.ini entry for Windows 95 in the boot selection menu reads "MS Windows." How might you edit Boot.ini to change this value to read "Windows 95 Rules!" instead? What part of the Boot.ini file does the appropriate entry reside in, and which entry should you edit?